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RADC-TR-71-247
Technical Report
January 1971

AD 518713

DIAGNOSTIC EXPERIMENTS FOR IVORY CORAL (U)

Aeronomy Corporation

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DIAGNOSTIC EXPERIMENTS FOR IVORY CORAL (U)

S. A. Bowhill
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Contractor: Aeronomy Corporation
Contract Number: F30602-70-C-0174
Effective Date of Contract: 19 January 1970
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PUBLICATION REVIEW

This technical report has been reviewed and is approved.

RADC Project Engineer

RADC Contract Engineer

ABSTRACT (U)

(S) In setting up models for the behavior of radio waves scattered from artificial spread F (ASF) irregularities, it is necessary to devise appropriate diagnostic techniques to determine the detailed morphology of the irregularities. One such experiment, using scintillation of satellite signals, is described and suitable experimental configurations are given. Possible remote effects at magnetic conjugate locations are described, together with the possibility of triggering artificial aurora. Experimental tests for these possibilities are outlined.

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CONTENTS (U)

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1. Diagnostic Experiments for Ivory Coral (U)

(S) Experiments for artificially producing changes in ionospheric electron density and temperature are being conducted by ESSA by using an HF transmitting facility located near Platteville, Colorado (Coleman, 1970; Utlaut, 1970). The system consists of a steerable beam antenna composed of ten elements in a ring array with about 20 dB gain and driven by a 2 megawatt transmitter. The average power aperture product is of the order of 10^4 megawatt-meter^2. The frequency range of operation is from 5 to 10 MHz. The geometry pertinent to the experiment is shown in Figure 1. The technique of producing changes in electron density consists of heating the ionosphere by operating the transmitter close to the critical frequency of the F layer.

(S) There are tentative experimental designs for gathering data concerning three effects associated with heating of the ionospheric F region by HF radio waves. The first, satellite scintillation, is known to occur with natural ionospheric spread F, and therefore offers the best possible means for determining the exact size and shape of the irregularities generated by the heating experiment. The second and third effects, generation of conjugate-point irregularities, and stimulation of auroral particle precipitation, are possible phenomena, and the purpose of the experiment is to detect whether they occur at all.

2. Satellite Scintillation (U)

(S) Scintillation is the phenomenon of random time variation of the amplitude or phase of a signal caused by inhomogeneities along the propagation path of a signal from the source to the observer. Satellite radio scintillation arises due to scattering of the satellite signal from irregularities in the

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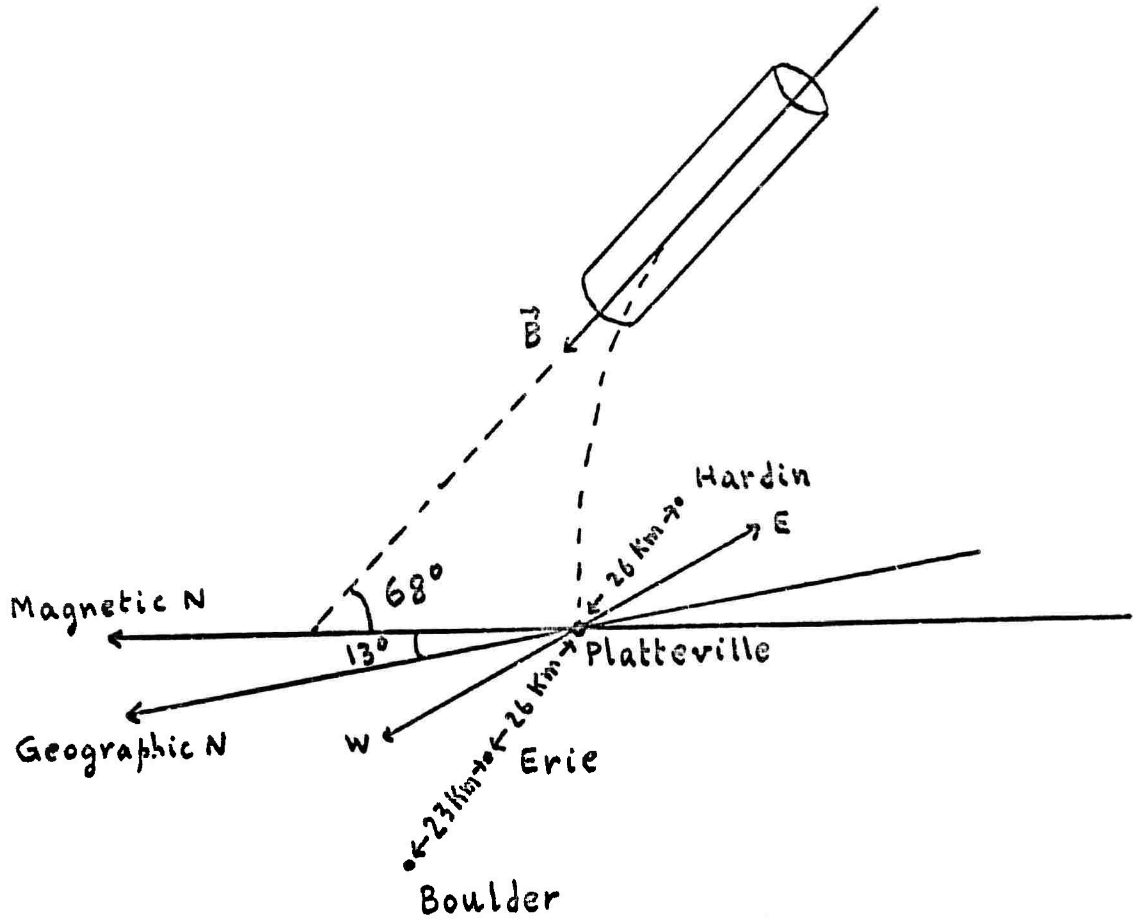

Figure 1. Geometry pertinent to the ionospheric heating experiment.

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ionosphere. Hence, it is a means of studying the location and the structure of such scintillation-producing irregularities.

(S) Prior to the advent of artificial earth satellites in 1957 and to a lesser extent even at the present time, the sources for studying scintillation have been signals from radio stars.

(S) The characteristics of the irregularities are deduced from the characteristics of the field strength patterns observed on the ground at one or more receiving sites. The drifts are obtained from time shifts between the arrivals of corresponding maxima in the amplitude fluctuations recorded by three receivers situated at the vertices of a triangle. Information concerning the sizes and shapes of the irregularities can be obtained in three ways:

1. From the fluctuations in the phase difference between the elements of an interferometer;
2. By determining the distance between two spaced receivers required to reduce the correlation between the fluctuations recorded by them to a specified value; and
3. From the time duration of an irregularity pattern which moves across a receiving site with known velocity.

(S) While the technique of radio start scintillation has the advantage that the source is provided by nature and, for the same reason, is best suited for studies such as frequency dependence of scintillation (Aarons, et al., 1967), there is no really accurate way of measuring the height of the irregularities. Attempts to measure the irregularity height through a comparison of phase and amplitude scintillation (Hewish, 1952) have been unsuccessful mainly because of the difficulty associated with phase scintillation observations. On the other hand, satellites are well suited for making irregularity height measurements.

A geostationary satellite serves as a source similar to a radio star except that it is fixed relative to the receiver and closer to it than a radio star; but still far enough to be considered as a distant source. Low-orbiting satellites, on the other hand, sweep across the sky in a short period thereby providing an almost instantaneous picture of the irregularity distribution.

(S) The most unambiguous results for irregularity height are provided by the spaced-receiver methods. One method using spaced receivers is the so-called "transition edge" method first used by Parthasarathy, et al. (1959). This method is based on the fact that when the ray path from the satellite to the receiver intercepts and passes the edge of a path containing irregularities, the received signal undergoes a sharp transition from slow, quasi-periodic Faraday fading to fast, random fluctuations in amplitude. By placing two receivers a few kilometers apart in the direction of satellite motion, and observing the transition times, the height of the irregularities is computed knowing the satellite velocity and height (McClure, 1964).

(S) Another method is based on the correlation of the output of two closely spaced receivers. The difference between this method and the transition edge method is that instead of measuring the ground velocity of the transition edge only, the ground velocity of the irregularity pattern as a whole is determined. By applying the first method to similar fades in the two outputs, a continuous height distribution for the entire observed irregularity region is obtained (Liszka, 1963). Or, by cross-correlating the output of the two receivers, the time delay corresponding to the ground velocity of the center of the irregularity region is determined and the average height computed (McClure, 1964; Yeh and Swenson, 1946; Paul, et al., 1970). By extending the two spaced receiver technique to at least three non-colinearly spaced receivers, it is

further possible to determine the orientation and size of the irregularities (McClure and Swenson, 1964). It is also possible to obtain the thickness of the irregularity region from corss-correlation provided that it is assumed that the irregularities are weak so that only single scattering is important. This condition is fulfilled if the frequency studied is sufficiently high.

The following research is concerned with:

(a) The range of suitable frequencies for such a satellite transmission experiment,

(b) The availability of low altitude and geostationary beacon satellites that satisfy the frequency requirements, and

(c) The location of ground stations required to measure the following properties of the irregularities:

(1) Horizontal size in the N-S and E-W directions

(2) Whether they are field aligned or not

(3) The overall horizontal extent of the irregularity region in the N-S and E-W direction

(4) The altitude region over which the irregularities extend, and

(5) The magnitude of the electron density perturbation as a fraction of the total electron density.

2.1. <u>Choice of frequencies</u> (S)

(S) The irregularity model assumed for computing the optimum range of frequencies consists of striated columns of ionization aligned with the magnetic field. The perturbation in electron density from the ambient in any one striation is statistically independent of the perturbation in any other striation. Plane earth and plane ionosphere are assumed. The geometry of

the line-of-sight from the satellite to a receiver on the ground, relative to the striations is illustrated in Figure 2. With reference to this Figure, the following notation is used:

ψ = angle between the vertical and the magnetic field $\vec{B}$

θ = angle between the magnetic field and the line-of-sight

α = elevation angle of the satellite from the receiver

T = thickness of the slab containing the irregularity region

h = height of the slab above the ground

d = scale of the striations normal to the magnetic field.

(S) The following quantities can be written with the aid of Figure 2 and Figure 3 which shows an enlarged view of one striation:

Thickness of one striation parallel to the line-of-sight = d cosec θ

Distance traversed by the ray in the slab = T sec $(\theta-\psi)$

Number of striations traversed by the ray in the slab (n) $= \dfrac{T \sec(\theta-\psi)}{d \operatorname{cosec}\theta}$

Scale of striations normal to the line-of-sight = d sec θ.

(S) The phase shift ϕ_j undergone by a satellite signal of frequency f Hz in propagating through the jth striation is given by

$$\phi_j = \frac{2\pi f}{v_p} d \operatorname{cosec}\theta \qquad (1)$$

where v_p is the phase velocity. Substituting

$$v_p = \frac{c}{\mu} = \frac{c}{\sqrt{1 - \dfrac{f_{N_j}^{2}}{f^2}}} \qquad (2)$$

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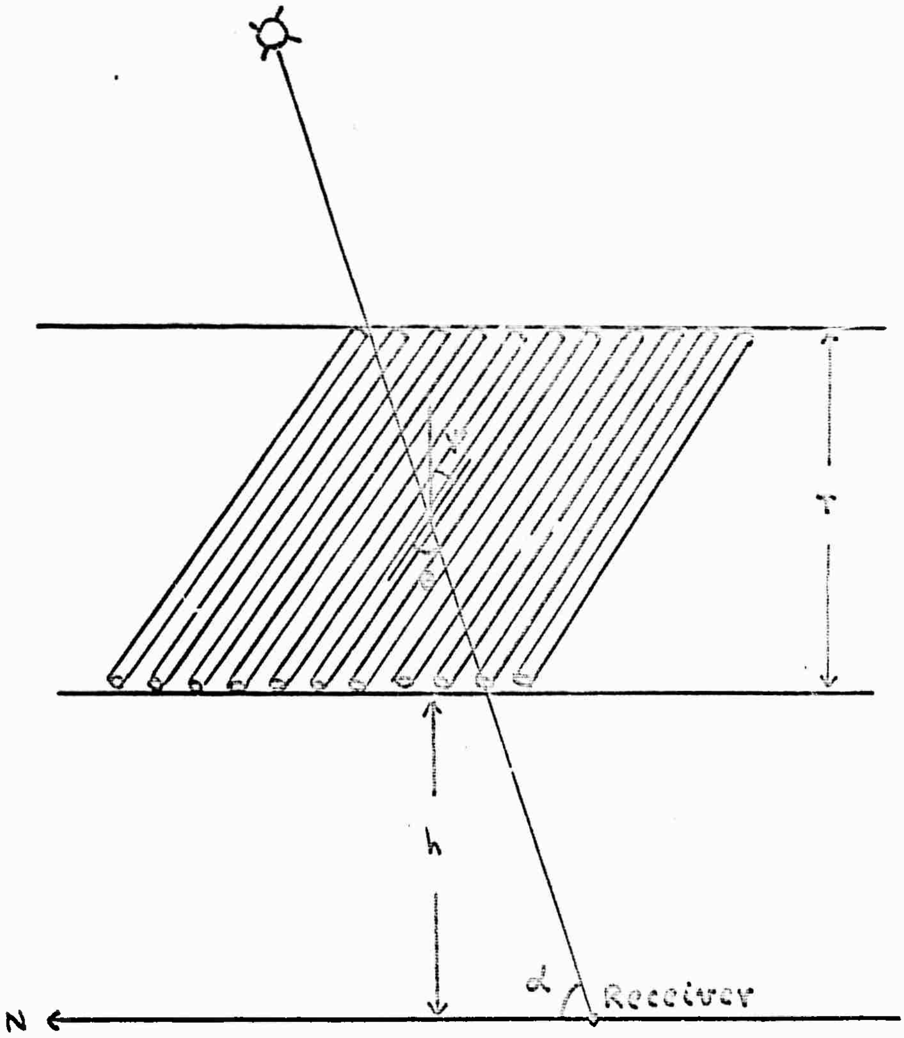

Figure 2. Geometry of the line-of-sight from satellite to receiver relative to the striations.

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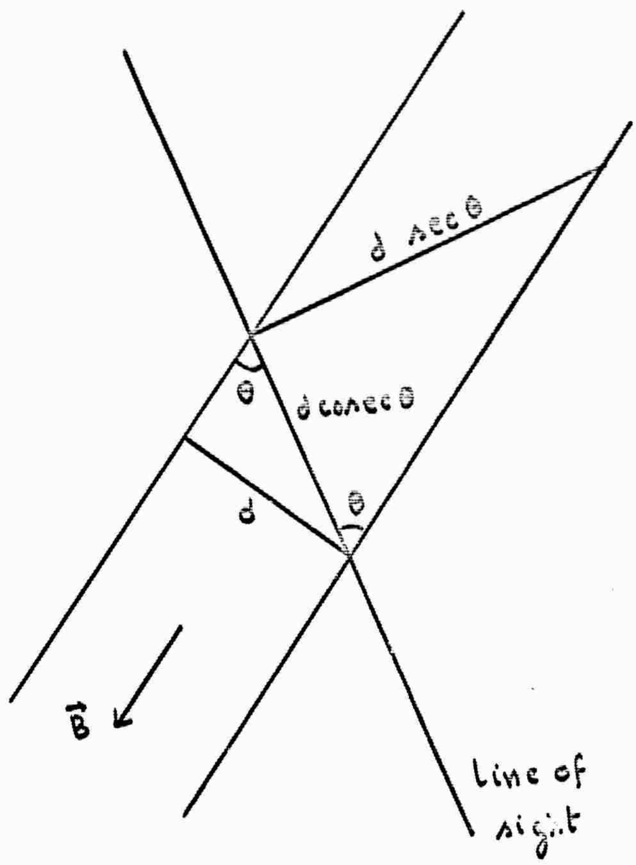

Figure 3. Enlarged view of one striation in Figure 2.

in (1) where μ is the phase refractive index, c is the velocity of light in free space and f_{N_j} is the plasma frequency in Hz in the jth layer normal to the line of sight, we have

$$\phi_j = \frac{2\pi f}{c} d \operatorname{cosec} \theta \cdot \sqrt{1 - \frac{f_{N_j}^2}{f^2}} \quad . \tag{3}$$

Assuming $f >> f_{N_j}$, (3) can be approximated as

$$\phi_j = \frac{2\pi f}{c} d \operatorname{cosec} \theta \cdot \left[1 - \frac{f_{N_j}^2}{2f^2}\right] \quad . \tag{4}$$

Substituting $f_{N_j} = \sqrt{80.6 N_j} \times 10^6$ where N_j is the electron density in electrons/meter^3 in the jth layer, we obtain

$$\phi_j = \frac{2\pi f}{c} d \operatorname{cosec} \theta \cdot \left[1 - \frac{10^{12} x 40.3 \ N_j}{f^2}\right] \quad . \tag{5}$$

For a perturbation ΔN_j in the electron density, the perturbation $\Delta\phi_j$ in the phase is given by

$$\begin{aligned} \Delta\phi_j &= \frac{2\pi f}{c} d \operatorname{cosec} \theta \cdot \left[- \frac{40.3 \ \Delta N_j}{f^2}\right] \times 10^{12} \\ &= - \frac{80.6\pi}{cf} \Delta N_j \cdot d \operatorname{cosec} \theta \times 10^{12} \quad . \end{aligned} \tag{6}$$

(S) Let $\Delta\phi$ be the fluctuating component of the phase of the signal received on the ground. The standard deviation in $\Delta\phi$ is given by

$$\sigma^2_{\Delta\phi} = \langle(\Delta\phi)^2\rangle - (\langle\Delta\phi\rangle)^2$$

$$= \sum_{j=1}^{n} \langle(\Delta\phi_j)^2\rangle \tag{7}$$

substituting (6) into (7), we obtain

$$\sigma^2 = \sum_{j=1}^{n} \langle(10^{12} \frac{80.6\pi}{cf} \Delta N_j \cdot d \text{ cosec } \theta)^2\rangle$$

$$= (10^{12} \frac{80.6\pi}{cf} d \text{ cosec } \theta)^2 \sum_{j=1}^{N} \langle(\Delta N_j)^2\rangle \quad . \tag{8}$$

Now, if we consider an independent layer normal to the line-of-sight, the electron density variation in this layer may be pictured as shown in Figure 4 where N_o is the ambient value, and s is the distance variable parallel to the slab. The standard deviation σ_{N_j} associated with the variation of N along the slab is given by

$$\sigma^2_{N_j} = \langle N_j^2(s)\rangle - \langle N_j(s)\rangle^2$$

$$= \langle(\Delta N_j)^2\rangle \tag{9}$$

substituting (9) into (8) and assuming that σ_{N_j} is constant for all j and equal to σ_N, we obtain

$$\sigma^2_{\Delta\phi} = n\,\sigma^2_N\,(10^{12} \frac{80.6\pi}{cf} d \text{ cosec } \theta)^2 \tag{10}$$

substituting for n, we have

$$\sigma^2_{\Delta\phi} = \frac{T\ \sec(\theta-\psi)}{d\ \text{cosec}\ \theta}\ \sigma^2_N\ \left(10^{12}\ \frac{80.6\pi}{cf}\ d\ \text{cosec}\ \theta\right)^2$$

or

$$\sigma_{\Delta\phi} = 10^{12}\ \frac{80.6\pi\sigma N}{cf}\ [T\ \sec(\theta-\psi)\cdot d\ \text{cosec}\ \theta]^{1/2}\ . \tag{11}$$

(S) We now find the approximate radius of curvature R of the emerging wavefront from the irregularity region with the aid of Figure 5. Thus,

$$\frac{R}{d\ \sec\ \theta} \sim \frac{d\ \sec\ \theta}{\frac{\pi}{2}\sigma_{\Delta\phi}\cdot\frac{c}{2\pi f}}$$

or

$$R \sim \frac{4\ d^2\ \sec^2\ \theta}{\sigma_{\Delta\phi}\ c}\ f\ . \tag{12}$$

To avoid interference between multiple modes, the radius of curvature of the emerging wavefront must be greater than the distance from the receiver, i.e.,

$$R > h\ \sec\ \theta$$

or

$$\frac{4\ d^2\ \sec^2\ \theta}{\sigma_{\Delta\phi}\ c}\ f > h\ \sec\ \theta \tag{13}$$

substituting for $\sigma_{\Delta\phi}$ in (13) from (11), we have

$$\frac{4\ d^2\ \sec^2\ \theta\cdot f^2}{10^{12}\times 80.6\pi\ \sigma_N\ [T\ \sec\ (\theta-\psi)\cdot d\ \text{cosec}\ \theta]^{1/2}} > h\ \sec\ \theta$$

$$f^2 > \frac{10^{12}\times 20.15\ \pi\ h\ \sigma_N}{d^2\ \sec\ \theta}\ [T\ \sec\ (\theta-\psi)\cdot d\ \text{cosec}\ \theta]^{1/2}\ . \tag{14}$$

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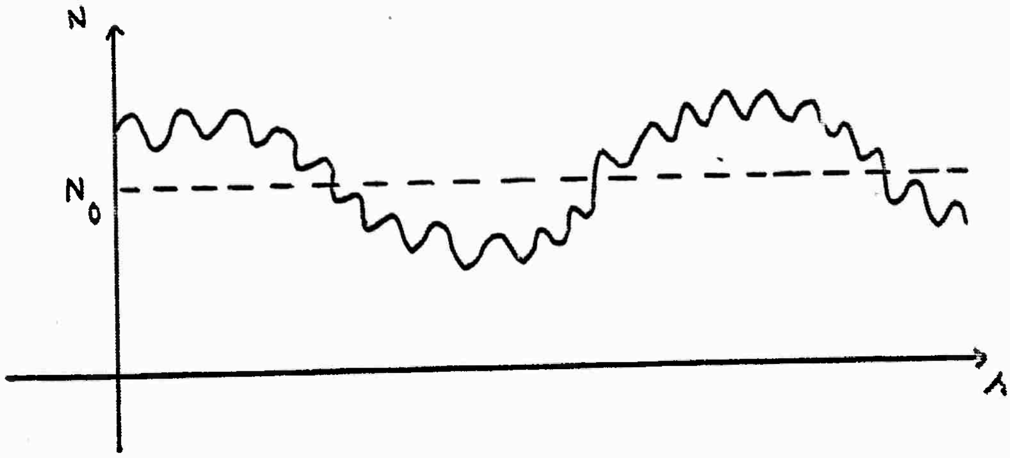

Figure 4. Electron density variation along an independent layer normal to the line-of-sight.

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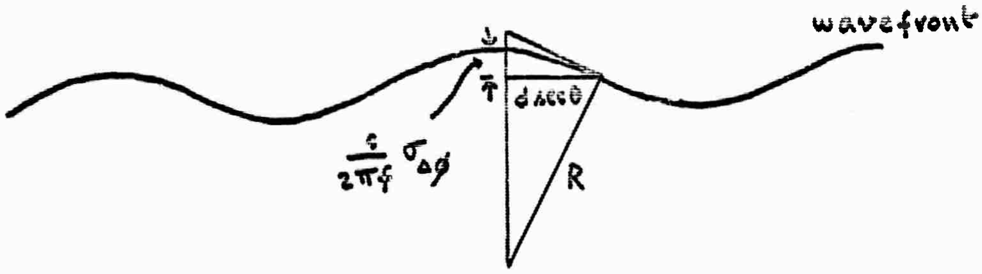

Figure 5. For finding the radius of curvature of the wavefront emerging from the irregularity region.

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Expressing

$$\sigma_N = kN = k \frac{f_N^2}{80.6} \times 10^{-12} \tag{15}$$

where k is a proportionality constant, (14) becomes

$$f^2 > \frac{\pi\, k\, h\, f_N^2}{4\, d^2 \sec\theta} \left[T \sec(\theta-\psi) \cdot d \operatorname{cosec}\theta\right]^{1/2}$$

or

$$f > \left[\frac{\sqrt{\pi}\, h^{1/2}\, T^{1/4}\, k^{1/2}\, f_N}{2\, d^{3/4}}\right] \left[\frac{\sec^{1/4}(\theta-\psi)\, \operatorname{cosec}^{1/4}\theta}{\sec^{1/2}\theta}\right] . \tag{16}$$

(S) Equation (16) is the criterion for the choice of frequency. There are, however, restrictions on the validity of (16). These are as follows:

(1) The number of layers traversed by the layer must be >> 1. For this to be satisfied,

$$\frac{T \sec(\theta-\psi)}{d \operatorname{cosec}\theta} \gg 1 .$$

(S) The breakdown of this condition occurs for values of θ near zero. Thus,

$$\frac{T \sec\psi}{d}\, \theta \gg 1$$

or

$$\theta \gg \frac{d \cos\psi}{T}$$

(2) The scale of striations normal to the ray path must be << T sec ψ, length of the striation along the magnetic field. For this to be satisfied,

$$d \sec \theta << T \sec \psi$$

$$\frac{d}{\sin (90^\circ - \theta)} << T \sec \psi$$

(S) The breakdown of this condition occurs for values of θ near 90°. Thus,

$$\frac{\pi}{2} - \theta >> \frac{d \cos \psi}{T} .$$

(S) We note that Equation (16) contains two factors one of which is independent of the satellite location and the other of which is a function of the satellite position. Substituting the following reasonable values for the parameters,

$$h = 300 \text{ km}$$

$$T = 100 \text{ km}$$

$$d = 1 \text{ km}$$

$$k = 0.1$$

$$f_N = 6 \text{ MHz},$$

we obtain the first factor as

$$\frac{\sqrt{\pi}\, h^{1/2}\, T^{1/4}\, k^{1/2}\, f_N}{2\, d^{3/4}} = \frac{\sqrt{3\pi} \times 10^{5/2} \times 10^{5/4} \times 10^{-1/2} \times 6 \times 10^6}{2 \times 10^{9/4}}$$

$$\approx 92 \text{ MHz} .$$

Now, for $\psi = 22^\circ$,

$$\frac{d \cos \psi}{T} = \frac{10^3 \cos 22^\circ}{10^5} = 0.0093 .$$

Hence Equation (16) is valid for

$$\theta >> 0.5^\circ$$

$$90^\circ - \theta >> 0.5^\circ .$$

In fact, the geometric factor has a value of about 1.9 for $\theta = 5°$, 1.6 for $\theta = 10°$ and 0.36 for $\theta = 85°$. Hence, the restrictions are only for a very small range of values of θ near 0° and 90°. The restriction near $\theta = 90°$ need not even be considered since $\theta = 90°$ does not occur within the useful range of satellite passage.

2.2. <u>Availability of beacon satellites and spacing of ground stations</u> (S)

(S) The computations in Section 2 indicate that the satellite transmitter frequency must be greater than about

$$92 \left[\frac{\sec^{1/2} (\theta-\psi) \operatorname{cosec}^{1/4} \theta}{\sec^{1/2} \theta} \right] \text{MHz} \quad .$$

Since the geometric factor is less than 1.6 for $\theta > 10$, a frequency of about 140 MHz would serve the purpose for $\theta > 10°$. This frequency is close to the frequency available on several satellites. The geostationary satellites which can be viewed from Boulder, Colorado, their approximate positions and elevation angles from Boulder are given in Table 1. Two low-orbiting satellites and their orbital parameters are listed in Table 2.

(S) ISIS-A is transmitting on command only at the request of the University of Western Ontario, London, Ontario. A request to Prof. P. A. Forsyth, Physics Department, University of Western Ontario, about a week in advance of the planned usage should be sufficient for having the beacon turned on. BE-C is usable only for the period of the day during which the satellite is in sunlight. We note from the inclinations that ISIS-A has essentially a polar orbit whereas BE-C has essentially a west to east orbit as viewed from Boulder. In view of the frequency and the polar orbit, ISIS-A seems to be preferable to BE-C. The polar orbit cuts across the magnetic field and provides an opportunity

Table 1

Data pertinent to geostationary satellites

Satellite	Approximate longitude	Approximate elevation angle	Frequency MHz
ATS-I	149°W	27°	137.35
ATS-III	47°W	15°	137.35
ATS-V	105°W	44°	136.47

Table 2

Date pertinent to low-orbiting satellites

Satellite	Period Minutes	Inclination Degrees	Apogee km	Perigee km	Frequencies MHz
ISIS-A	128.3	88.4	3521	579	137.95
BE-C	107.8	41.1	1310	939	40, 41, 360

for t ,ting the field alignment of the irregularities. Thus, choosing 137 MHz for the frequency, we have for the same parameters listed in Section 2,

$$\sigma_{\Delta\phi} = 10^{12} \frac{80.6\pi \ \sigma_N \ T^{1/2} \ d^{1/2}}{df} \sqrt{\sec\,(\theta-\psi)\ \mathrm{cosec}\ \theta}$$

$$= \frac{\pi \ k \ f_N^2 \ T^{1/2} \ d^{1/2}}{cf} \sqrt{\sec\,(\theta-\psi)\ \mathrm{cosec}\ \theta}$$

$$\sigma_{\Delta\phi} = \frac{\pi \times 10^{-1} \times 36 \times 10^{12} \times 10^{5/2} \times 10^{3/2}}{3 \times 10^8 \times 137 \times 10^6} \sqrt{\sec\,(\theta-\psi)\ \mathrm{cosec}\ \theta}$$

$$= 2.75 \sqrt{\sec\,(\theta-\psi)\ \mathrm{cosec}\ \theta} \text{ rad.}$$

The values of the geometric factor $\sqrt{\sec\,(\theta-\psi)\ \mathrm{cosec}\ \theta}$ is about 3.4 for $\theta = 5°$, 2.4 for $\theta = 10°$ and 1.5 for $\theta = 85°$.

(S) The horizontal scale of tne striations at the irregularity heights is d sec ψ in the N-S direction and d in the E-W direction. For overhead position of the satellite at a height of 2000 km, the horizontal scale of phase perturbations on the ground would be d sec $\psi \times \frac{2000}{1650}$ or about 1.3 km in the N-S direction and about 1.2 km in the E-W direction. As the elevation angle decreases, the scale in the N-S direction increases whereas the scale in the E-W direction remains about the same assuming an overhead passage of the satellite in polar orbit. The spacing between the receiving locations consisting of a three station set up should be chosen on the basis of these scale sizes.

2.3 <u>Location of ground stations for geostationary satellites</u> (S)

(S) ATS-III is drifting at the rate of 0.142° per day towards west. Since the elevation angle as seen from Boulder for the present location of ATS-III

is already as low as 15°, it would not be suitable for the proposed experiment. We are therefore left with ATS-I and ATS-V. The location of the heated region when the heating wave is ordinary mode is approximately 45 km north of Platteville. Hence, the line-of-sight from the satellite to the receiver must pass through the peak of the F layer approximately 45 km north of Platteville. For the locations of ATS-I and ATS-V shown in Table 1, for the ground station locations to satisfy this requirement are approximately as follows:

Satellite	Ground stations to be location near
ATS-I	43.4°N, 96.2°W
ATS-V	42.9°N, 104.3°W

(S) The above-mentioned locations of ground stations fall near the northwestern corner of Iowa and in the east central portion of Wyoming, respectively.

3. Conjugate-Point Effects (S)

(S) The mechanism by which irregularities of ionization are produced by HF heating of the F layer is not understood. However, redistribution of ionization certainly occurs, and the irregularities are probably field-aligned. Therefore, the necessary horizontal transport of F-region ionization must result from the existence of horizontally varying electric fields, normal to the earth's magnetic field.

(S) Since the geomagnetic field lines, at F-region heights and above, are nearly perfect electrical conductors, these electric fields should be conducted into the magnetosphere and should appear at the geomagnetically conjugate F region. There, they may be expected to convect the ionization into an irregular structure, mirroring that at the other end of the field tube (where the heating is taking place). Irregularities generated in this way in the southern

hemisphere would produce spread in the F-layer return for a vertical-incidence ionosonde located under the conjugate point. In essence, therefore, the experiment would involve continuous observation of the Boulder conjugate point with a sweep frequency ionosonde, while the heating at the Boulder station was cycled on and off. Naturally, the experiment should be carried out with spread F is absent in the unheated ionosphere at both stations.

(S) Roederer (1969) has given a full survey of this type of conjugate-point effect and has pointed out the desirability of simultaneous geomagnetic micropulsation observatons.

(S) The conjugate point to Boulder (40.03 N; 105.30 W) has been given by Roederer as 54.4 S; 131.9 W. This location, approximately midway between the southern tips of New Zealand and South America, has no land in the vicinity, and an aircraft-borne ionosonde would therefore be necessary. Such a facility has been developed by AFCRL, and has been used for eclipse and auroral observations; high-quality ionograms can easily be obtained by this equipment.

(S) It is therefore proposed that a series of flights by made in the vicinity of the conjugate point to Boulder, on nights when the Boulder ionograms show a quiet condition. The aircraft should stay in the vicinity of the conjugate point for at least two hours on each night, during which time the Boulder transmitter would be cycled on and off, with a period of (say) 10 minutes. Ionograms from the conjugate point would then be correlated with those at the local site to determine whether irregularities produced at the heating ionosphere are reproduced at the conjugate point.

(S) In order to determine the feasibility of the experiment, and the sensitivity of the aircraft-borne ionosonde to these heat-induced irregularities, a necessary preliminary to the conjugate-point experiment will be the use of

the aircraft at Boulder, in a brief program of coordinated ground-based and aircraft-borne measurements on spread F while the heating transmitter is in use. This experiment would also have the additional output of mapping the spatial extent of the spread-F irregularities (and demonstrate that they are a localized phenomena associated with the heated ionosphere). As a bonus from this pilot experiment, the average ionization cross section in the vertical and horizontal directions could be obtained for the heated and unheated ionosphere (thereby aiding greatly in the interpretation of the ground-based data).

4. Artificial Auroral Precipitation (S)

(S) Kennel and Petschek (1966) have suggested that stably trapped particles in the magnetosphere could be precipitated by magnetospheric waves. It is entirely possible (though the detailed theory must be the subject of later study) that the electric fields associated with the generation of F-region striations could produce precipitation of trapped particles in the auroral zone. Giant pulsation of the appropriate time scale have been observed at geomagnetic conjugate points by Nagata, et al. (1963); and the precipitation of auroral particles in this way would give localized effects similar to those of auroral substorms.

(S) Experimental design for such a program poses considerable uncertainties. Principal questions appear to be:

(1) Can the auroral zone F region be heated remotely from the Boulder transmitter?

(2) Is remote spread F generated by such remote heating?

(3) Do the electric fields associated with the spread F produce dumping of auroral particles? If so, under what range of auroral activity conditions?

(4) What is the spatial extent of the artificial auroral ionization produced, and what will be its effects on communication and/or tracking?

(S) It seems that the first step will be to determine, by steering the Boulder heating transmitter to a location over one or more remote ionosondes, the feasible range of the remote spread-F effect. When this is determined, an ionosonde site should be selected or established, north of Boulder, just inside the auroral zone. The ionosonde would then serve to indicate both the presence of spread F, and the existence of auroral particle precipitation, associated with the switching on of the heating transmitter.

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13. ABSTRACT

SECRET ABSTRACT

(S) In setting up models for the behavior of radio waves scattered from artificial spread F (ASF) irregularities, it is necessary to devise appropriate diagnostic techniques to determine the detailed morphology of the irregularities. One such experiment, using scintillation of satellite signals, is described and suitable experimental configurations are given. Possible remote effects at magnetic conjugate locations are described, together with the possibility of triggering artificial aurora. Experimental tests for these possibilities are outlined.

14 KEY WORDS	LINK A		LINK B		LINK C	
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